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Amendments to section „1. Introduction" of the specification, in response to the Examination Report dated 9/22/2005

The changes to the previous versions are marked as follows: (i) the deleted text is shown by strike-through except that double brackets [[ ]] placed before and after the deleted text are used if the deleted text has 5 or fewer characters, (ii) new text is underlined.

~~**1. Introduction**~~ FIELD OF THE INVENTION

The present invention relates to methods for establishing emotions, such as contentment, joy, dissatisfaction, grief, liking, love, dislike, hate, revenge, depression, sadness, fear, envy, jealousy, shame and feeling guilt, in robots, agent systems and entertainment software. The emotional importance of objects and situations for a robot or agent is described.

DESCRIPTION OF THE RELATED ART

Experts in robots and agent systems are concerned with implementation of emotions in robots/agents ~~Computer scientist are concerned with representation of emotions in electronic devices since several years.~~ because they:

(a) concluded that without emotions a robot/agent can be neither intelligent nor autonomous, e.g. M. Minski said that „the question is not whether intelligent machines can have any emotions, but whether machines can be intelligent without any emotions" (in The Society of the Mind; Simon and Schuster; New York, 1986), and wanted establish emotions in a robot/agent in such a way that it would handle intelligent and autonomous;

(b) wanted to make robots more userfriendly or to have emotional virtual persons in entertainment or advertising software;

(c) attempted to recognize and measure emotions of a man.

Problem (a) is not solved until now, although there were attempts to get motivated robots/agents; examples: (i) Agent in ~~I know the following papers (patents) which concern the representation of emotions in electronic devices~~[[:]] Padgham & Taylor [PTA] (1997) [[,]] - it can be used only as a toy. Robots in (ii) T. Skibata & K. Ohkawa &K. Tanie „Spontaneous Behavior of Robots for Cooperation - Emotionally Intelligent Robot System",

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ICRA'96, Procced. IEEE 1996, and in (iii) M. S. El-Nasr & M. Skubic „A Fuzzy Emotional Agent for Decision-Making in a Mobile Robot", IEEE, p. 135 - 140, 1998, may be treated merely as a first step towards building an emotional agent. Motivated agent system in (iv) A. Schurmann [AS1], 1998, and [AS2], 1998, may be used in not complex situations where not complex activities are needed.

A key problem in developing intelligent and autonomous robots/agents is to judge how good or bad is a recognized object or situation for the robot/agent, at present. An attempt to solve this problem is to associate a vector of attributes, such as hope, frustration, love, hate, joy, despair, fear; these attributes are weighted when calculating how good or bad is the object for the robot/agent. This is a rough judgement method - the used emotions are too general, and the current intensities of desires and needs of the robot/agent are not taken into account. Such judgement of objects and situations is not intelligent enough in many cases. Therefore, also the behavior of a robot/agent based on such object judgement is not intelligent in many situations, e.g. when a robot needs energy supply and an urgent situation appeared.

The judgement method given in El-Nasr & at all, (iii), is even less satisfactory than the method mentioned above. The robot described there has only emotions anger, pain and fear. To an recognized event or object is associated a desirability attribute measuring how desirable is this event or object with regard to goals. Using this desirability and the priorities associated to goals, the priority of emotion with regard to a goal is calculated; then, using a rather large number of emotional rules, the activity to be executed is chosen. Because of associating a desirability attribute with regard to goals, this method of object judgement is a very rough one and has very restricted application.

In my said in (iv) papers, an agent system has desires with respect to needs of the agent; the above mentioned basic emotions (hope, frustration, love, etc.) are not considered. In these papers, to object and situations are associated desire attributes with regard to the needs of the agent; such desire attribute shows how the object or situation increase or decrease a desire intensity with regard to a need. These desire attributes enable acceptable judgement of recognized object and situations, if we accept that the agent has rather restricted intelligence and autonomy. My papers in (iv) do not solve the problem (a), if we want an intelligent and autonomous robot/agent.

Problem (b) was investigated in: (v) Mizokawa & T. Iwata-Shi & Shizuoka-ken „Control system and method for controlling object using emotions and personality generated in the object", Eur. Pat EP 0978790A1, Febr., 09 2000, (vi) Breese & Ball [BRD] (1999), (vii) Brush & at all [BDL] (1998), (viii) Clynes [CLY] (1996),

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(ix) Kawamoto & Omura [KAO] (1994), (x) Knight & at all [KMS] (1997), (xi) Skelly [SKE] (2000), (xii) Tow [TOW] (2000) , (xiii) K.Lee „Integration of Various Emotion Eliciting Factors for Life-like Agents", ACM, p. 155 - 158, 1999, and (xiv) R. Nakatsu & J. Nicholson & N. Tosa „Emotion Recognition and Its Application to Computer Agents with Spontaneous Interactive Capabilities", EBAA'99, Workshop on Emotion-Based Agent Architectures, Seattle USA, May 1999 . These papers/patents do not consider the problem (a).

Problem (c) is not solved in a satisfactory way - no published method recognizes or measures emotions reliable on basis of facial expression, voice prosody or motion behavior, e.g. the methods given in (v), (vi) and (xiv).

In all said papers/patents, except my papers, are considered only the so called basic emotions (happiness, sadness, love, hate, fear, acknowledgement, expectation, aggressiveness, expectation), which can represent only general emotion states of a robot/agent or a virtual person. In my said papers these emotions are not considered; the motivation of a robot/agent to execute an activity is there determined by means of desires with regard to needs of the robot/agent. ~~In these papers, emotions are modelled in other way than below and not sufficient.~~

1. BRIEF SUMMERY OF THE INVENTION

In my invention, satisfactions and desires with regard to needs of a robot/agent or a virtual person (denoted by *Pd*) are the primary emotions. The emotions contentment, joy, dissatisfaction, anger, grief, sadness, liking, love, dislike, hate, retaliation and revenge, frustration, depression, envy, jealousy, shame and feeling guilt are secondary emotions; the intensities of these secondary emotions are obtained by short procedures or rules from intensities of satisfactions and desires with regard to the needs of *Pd*. In this way, the emotional states of *Pd* and the development of emotions are described more precisely than in the methods given in the papers/patents (i),...,(xiv) mentioned in the above paragraph.

The established intensities of satisfaction and desire of *Pd* with regard to a need enable to connect a stimulus pattern, with regard to that need, with object and situation models. Such stimulus pattern with regard to a need describes the expected alterations of satisfaction and desire intensities with regard to said need, in a time period, when *Pd* has recognized an object or a situation as an instantiation of said object or situation model containing this stimulus pattern. By stimulus patterns, connected with an object or a situation, and current intensities of satisfactions and desires, the current stimulus intensity of said object or situation is calculated. This stimulus

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intensity measures, satisfactory, how good or bad is said object or situation for *Pd* at present. Because stimulus patterns describe much more precisely how emotion intensities change, than said, in the above paragraph, vector of attributes (such as hope, frustration, love, hate, joy,...), the said stimulus intensity of an object or situation measures more intelligently the importance of this object or situation for *Pd*, at present; by stimulus intensity of a situation, a robot can judge which of two situations is more urgent, at present. Additionally, said stimulus pattern with regard to a need, enables to calculate the expected intensities of satisfaction and desire with regard to the need, at present and in the future, when *Pd* has recognized an object or a situation.

Due to said current stimulus intensity of a situation, an intelligent motivation of *Pd* to execute an activity can be determined (however, such motivation is not considered in this description) and in this way solve the said problem (a).

~~The representation of emotions given in this description is based on notions (desires and satisfaction, stimuli) introduced in my papers [AS1] (1998) and [AS2] (1998). The representation of emotion states, given below, enables very good simulation of emotions: a) In Internet and entertainment software one may represent virtual people who behave emotional, according to the changing surrounding, and understand emotions of other virtual people, e.g. a virtual man in Internet who expresses emotions when he shows ware. b) In agent systems which handle and communicate with people. Such agent system could not only express emotions according to actual situations but also understand emotions of people in surroundings of the agent system. These applications can be made if also other problems are solved, e.g. perception which can identify emotions, connection of behaviors with emotion states.~~

In paragraphs 3,....7 below are given short procedures and rules which determine (and show the development of) the intensities of the following emotions using said intensities of satisfactions and desires with regard to needs of *Pd*. ~~In this paper, the following stimulus and emotion states are formal described: the stimuli of *OSA*, where *OSA* denotes an object, a situation or an activity;~~

- contentment, joy, happiness, dissatisfaction, annoyance, anger, grief, sadness, pain and suffering with regard to a need of *Pd* ;
- positive emotions ~~feelings~~ (liking, affection, love) and negative emotions ~~feelings~~ (dislike, anger) to/for an object, a situation or an activity [[*OSA*]] ;
- contentment ~~satisfaction~~ and joy when a [[goal ( ]] goal situation [[ )]] is achieved; dissatisfaction, anger and disappointment when a goal situation is not achieved;

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- retaliation and revenge on an object, hate to an object;

- frustration, depression [[,]] and sadness [[,]] with regard to a person, an object or a goal;

- envy [[,]]at a success or a property of a person or an other robot/agent;

- jealousy [[,]] and shame ; and

- feeling guilt with regard to a living object, a robot/agent or a group of persons or robot/agents, when *Pd* has made damage to them or violated some norms or rules .

The intensities of some of these emotions, determined according to my invention, can be used to control and to measure the efficiency of the robot/agent *Pd* as follows:

- The intensity of contentment, joy, happiness, dissatisfaction, annoyance, anger, grief, sadness, pain and suffering with regard to a need, *b*, of *Pd* measures how good or bad *Pd* has realized the need *b*; if *b* denotes the need „achieve goal situation *SMz*", then this intensity measures how good or bad *Pd* has realized the achieving of the goal *SMz*;

- The intensity of positive emotion (or negative emotion) towards an object or a situation measures how useful (or how great obstacle, respectively) has been this object or situation for *Pd*;

-The intensity of frustration with regard to a need shows how bad *Pd* has been able to realize this need;

-The intensity of fear measures the un-ability of *Pd* to cope with a situation or to achieve its goal, when executing an activity;

The intensity of shame measures how strong *Pd* has violated some norms or rules.

The invention is also a good solution of the, said in the paragraph above, problem (b), because it enables

- to get more exactly the emotional personality of an agent or virtual person, than the other existing methods, and

- to show how emotions of a virtual person/agent develop.

Because the invention differs from other existing methods for establishing emotions in a robot/agent, the following description is very detailed and contains many examples. The function notation, e.g. *bef(Pd,b,t)*, *zful(Pd,b.t)*, *abhas(Pd,OS,t)* etc., is used only because of its good legibility. I could use also the notation $bef_{Pd,b,t}$, $zful_{Pd,b,t}$, $abhas_{Pd,OS,t}$ etc. to represent emotion intensities, however this notation is not easily legible.

DETAILED DESCRIPTION OF THE INVENTION

2. Representation of Desires and Patterns of Stimuli

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